Multi-angle detecting method for the defects of the high-reflective products

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Abstract

Visual image technology has been widely used in the defects detecting, classification, automatic recognition and measuring of industry production. However, it is hard to enhance the resolution and precision of image measurement. The imaging quality depends on the quality of the device, such as image sensor, image acquisition card and so on.

Without increasing the device quality, a new method is presented to solve the above problems. The directional measurement technology of high-reflective metallic surface is studied through different measurement angles. With the multi-angle measurement results, the realization possibility will be analyzed. On this basis, we will find the synthetical method of measuring image information by multi-angles and the proper image processing technology.

It is demonstrated by extensive experimentation, compared with the single image of products, that the multiple images could be processed more flexibly and more effectively. Therefore, the system of image vision can acquire the high resolution and also be robust and self-adjusting in the industrial environment.

Keywords: Multi-angle, differential, high-reflective, complementary, axial-symmetrical, photoelectric

1. Introduction

For nowadays traditional image detection way of processing with only one image, the resolution and precision of the results can hardly be improved because that the information collected from single image is too little to draw a valuable conclusion. So a new area of image processing which is called multi-image detection and measuring technique is put much focus on. In my paper, one new style of visual detecting and measuring system, different from the traditional method of single-image technology, will be presented in details.

The directional measurement of the high-reflective metallic material of the product surface can help us get over the problem that limited the level of the resolution and precision of intelligent image technology [1].

2. Instruments and methods

In the experimental environment with no stray light, three cameras with the same photoelectric characteristics and the product ready to be detected will be placed in one mechanical plane framework.
Figure 1 shows the framework of the multi-image detection system. During experiment, the input angle should be kept equally to the output angle.

The input and output angles could be changed to any degree between $0^0$ and $90^0$ in the axial-symmetrical directions. But the images of camera 2 and camera 3 would be distorted more and more seriously with the increase of the value of the angle. If your product is in circle style, then the images of the product captured using camera 2 and camera 3 would turned into ellipse with the variable ratio of the long-short axis along with the changing of the angles.

In this paper, I choose the $60^0$ as the value of the input angle and also the output angle to discuss. With the flux of the light source changing, the images of the products can be captured differently.

3. Results

Figure 2 shows the three pairs of images picked up from the groups of images obtained in series of the brightness of the light. The two images of each pairs are captured at different current level, the left in the situation of 750mA current, and the right in the situation of 112mA current.

![Fig. 2 (a) images obtained from the camera 1, (b) images obtained from the camera 2, (c) images obtained from the camera 3.](image-url)
From the images above, we can conclude that in the first two pairs, the valuable information is absolutely separated from the background without any operations like removing noise spots [2]. Camera 2 gets the light field of the product.

However, the third pair needs some operation to separate the product information from the background because most values of the pixels in the foreground is nearly the same as the background. So imagining the last two pairs of images have the same long-short ratio, we can use the images of camera 2 to make a mask field for the last pair of images. Camera 3 gets the dark field of the product.

The image captured by the camera 2 in the situation of 750mA current can be used to make a mask field. Then with the intensity of 30 as the threshold value, the original image can be turned into a binary image with the white pixels representing the foreground information and the black pixels representing the background information. So we can get the mask image.

Considering the last two pairs of images have different sizes, the algorithm of Radon can be applied to get the approximate position of the ellipse center and the length of the long and short axis. With that information, the last pair of images can be resized [3] to the proper size and moved to the perfect position for the differential operation [4].

The following step is to apply the Radon algorithm to the mask image, and then the result of the operation is shown below in Fig. 3.

![Fig. 3. The result of the radon algorithm.](image)

In the operation of Radon algorithm, the projection of the image intensity is along a series of radial lines oriented at a range angles from 0° to 180°. In Fig. 3, we can get the findings that the center of the ellipse is almost the center of the rectangle. The length of the long axis is the result of the \((106-(-106))\) that equals to 212 pixels, and the length of the short axis is the result of the \((93-(-93))\) that equals to 186 pixels.

With the value of the long and short axis of the ellipse in the mask image, the images of camera 3 can be resized to fit the images of camera 2. Then the mask image can be used to the images of camera 3 to remove the noise spot. It is the And operation that happened between pixels of the mask image and pixels of the images of camera 3. So finally we can get the images in Fig. 4.

![Fig. 4. The result of and operation between mask pixels and original image pixels.](image)
For improving the contrast of the two images above, two more operations is adopted here shown below.

1. \( \text{Pixels(Differential)} = \text{Pixels(750mA)} - \text{Pixels(112mA)} \);
2. \( \text{Pixels(Adding)} = \text{Pixels(750mA)} \times 1.3 + \text{Pixels(112mA)} \).

So the final images are shown in Fig. 5 below.

![Fig. 5](image)

Fig. 5. The result of the differential and adding operations for pixels.

Finally with the two elements of the differential operation, that is images in Fig. 5 and images (b) in Fig. 2, we can step into the final task. There are totally eight rules that are applied to the differential operation shown below. Under the rules, we get eight final images shown in Fig. 6 and Fig. 7.

1. \( \text{Pixels(Rule1)} = \text{Pixels(Adding)} - \text{Pixels(750mA of Camera 2)} \);
2. \( \text{Pixels(Rule2)} = \text{Pixels(Differential)} - \text{Pixels(750mA of Camera 2)} \times 0.15 \);
3. \( \text{Pixels(Rule3)} = \text{Pixels(Adding)} - \text{Pixels(112mA of Camera 2)} \times 0.58 \);
4. \( \text{Pixels(Rule4)} = \text{Pixels(Differential)} \times 2.4 - \text{Pixels(112mA of Camera 2)} \times 0.3 \);
5. \( \text{Pixels(Rule5)} = \text{Pixels(750mA of Camera 2)} - \text{Pixels(Differential)} \);
6. \( \text{Pixels(Rule6)} = \text{Pixels(750mA of Camera 2)} - \text{Pixels(Adding)} \times 0.5 \);
7. \( \text{Pixels(Rule7)} = \text{Pixels(112mA of Camera 2)} - \text{Pixels(Differential)} \times 4.5 \);
8. \( \text{Pixels(Rule8)} = \text{Pixels(112mA of Camera 2)} - \text{Pixels(Adding)} \times 1.35 \).

![Fig. 6](image)

Fig. 6. The result of differential operation using the rule 1 to rule 4.

![Fig. 7](image)

Fig. 7. The result of differential operation using the rule 5 to rule 8.
4. Discussion and conclusion

In this paper, we can know that the differential operation between the light field and the dark field of the product can make the texture of the defects and the edge of the product much easier to recognize. To some extent, the resolution of the images is improved compared with the original image. Therefore, the possibility of the automatic recognition through computer is increased.

Future work will be focused on defects of the products in other types in order to improve the ability of dynamic recognition and classification. We also need to find a new way to calibrate the framework and the cameras, so the following process done with the algorithm will be greatly eased.

References